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JAVAMIX: A TACTICAL DECISION AID TO EVALUATE MINEFIELD CLEARANCE PLANS

by

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JAVAMIX: A TACTICAL DECISION TO EVALUATE MINEFIELD CLEARANCE PLANS

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ABSTRACT

A Tactical Decision Aid (TDA) for mixed minefield clearance, JAVAMIX, was designed, developed and tested. The TDA uses a Monte Carlo Simulation and it is based on the Monte Carlo option of the TDA MIXER (Washburn, 1995). The JAVAMIX GUI allows the user to introduce different plans based on the sweep and resource types available and mine types expected. To clear the minefield the user is asked to choose a parameter file and to introduce a plan. Output tables are presented in a DOS window and permit the user to easily visualize if the chosen plan is tactically executable. The design of the system permits future developments such as the implementation of MIXER's other options and the introduction of new parameters.

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THESIS DISCLAIMER

The reader is cautioned that the computer programs developed in this research may not have been exercised for all case of interest. While every effort has been made, within the time available, to ensure that the programs are free of computational and logic errors, they cannot be considered validated. Any replication of these programs without additional verification is at risk of the user.

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I. INTRODUCTION

A. BACKGROUND

Mine warfare at sea is an extremely important aspect of naval capabilities. For example, the Japanese loss of shipping to mines, in the last 5 months of the World War II, was almost equal to the United States Navy loss of ships to German submarines in the Atlantic, during the entire war [1]. Nonetheless, mine warfare tends to be neglected by many navies.

The low interest in and neglect of mine warfare can probably be ascribed to its not being seen as one of the 'glamorous' or 'high profile' functions of a navy. Mine counter-measures tend to be even less glamorous. Although clearing mines is a very dangerous task, it is usually drawn out, arduous and boring.

Notwithstanding this low interest, the mining campaign against Japan, in the end of World War II, sunk or severely damaged 670 Japanese ships. And this accounted for almost all the ships the Japanese had at that time [1]. All navies should be aware of the risks mines pose to their fleets and ensure that they develop and maintain a mine warfare capability.

Since the decade of the 1970s, Tactical Decision Aids (TDA) have been developed to help planners of Mine Countermeasures. MIXER (Washburn, 1995) is an example of a TDA for mixed minefield clearance. MIXER is implemented in FORTRAN code and, in its current form, it is usable only in the hands of an expert. It has no graphics and little in the way of the user-friendly features that should be part of an operational TDA.

B. PROBLEM STATEMENT

MIXER has five options and one of them is a Monte Carlo Simulation. Monte Carlo Simulation closely imitates what happens in reality and given current computer speeds it appears to be usable tactically. This thesis designs and implements the Java code, together with a GUI to implement the Monte Carlo option of MIXER. The resulting system is called JAVAMIX.

C. SYSTEM DESIGN

The JAVAMIX GUI allows the user to introduce different plans based on the sweep and resource types available and mine types expected. To clear the minefield the user is asked to choose a parameter file and to introduce a plan. Output tables are presented in a DOS window and permit the user to easily visualize if the chosen plan is tactically executable.

The design of the system permits future developments such as the implementation of MIXER's other options and the introduction of new parameters.

JAVAMIX is designed to allow the user to make the necessary changes to the initial plan on the screen. After entering the clearance plan the user can run the simulation and verify if the plan is executable. Based on the output he can decide what changes could be made to the plan. All the parameters are written in an input parameter file and the user has the option to choose which file to use. This option gives the user more flexibility because it allows him to use the appropriate parameters based on the scenarios. The design of the system is presented schematically in Figure 1.

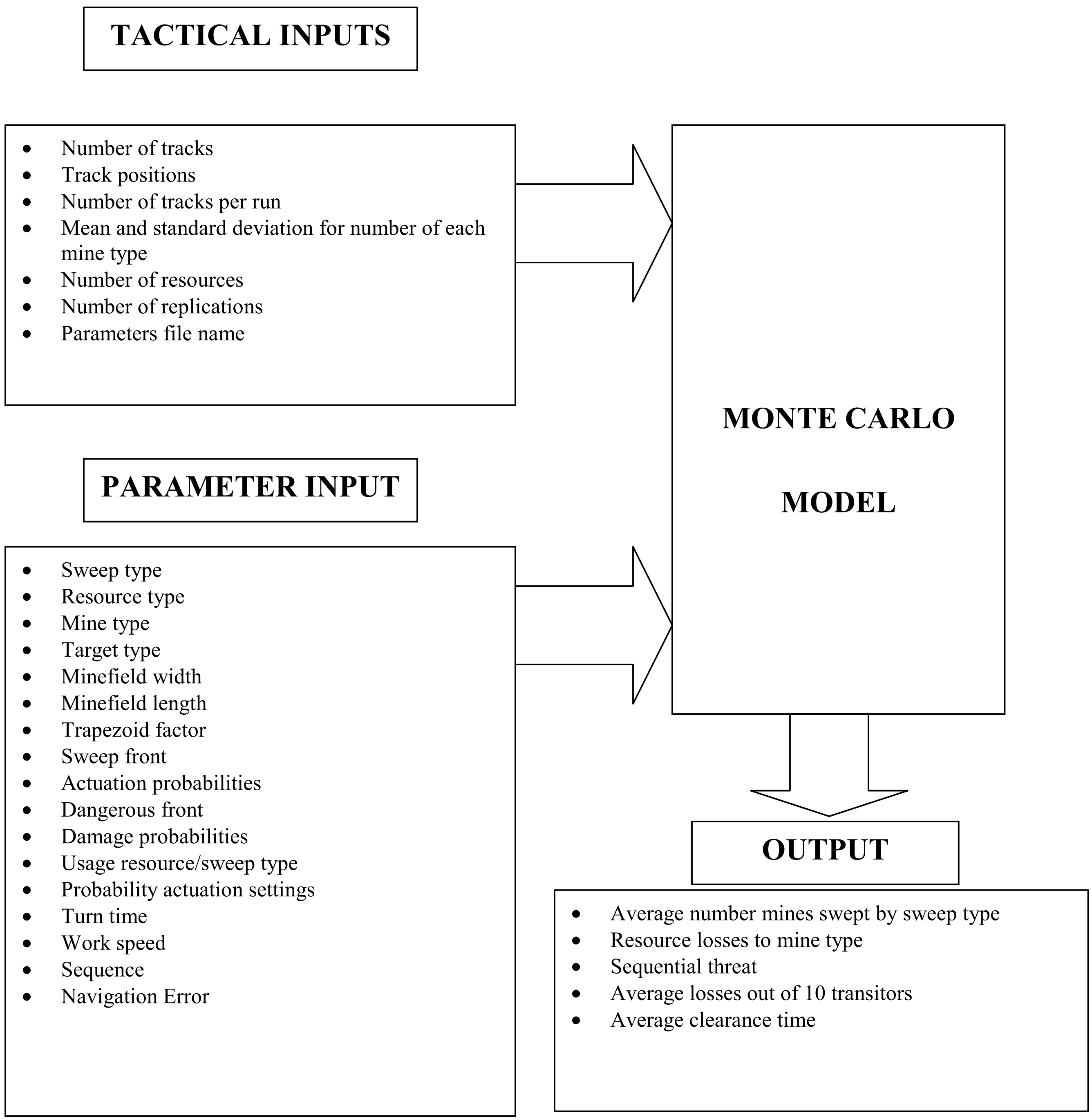

Figure 1. System Design.

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II. JAVAMIX GRAPHICAL USER INTERFACE

A. WHY CREATE A GRAPHICAL USER INTERFACE?

The widespread availability of modern computers, especially Personal Computers (PC), has lead to the development of computer programs for a wide variety of problems. Graphical interfaces for these programs have increased the effectiveness of the man-computer system. In the military, GUIs play important roles in a wide variety fields, especially for tactical decision aids. It's very important for a military user to have a user-friendly interface to allow better decisions in a battlefield or during mission planning. Today the Windows-style interface is widely accepted among users, and its look-and-feel is the industry standard for application development. JAVAMIX implements a GUI in this style for MIXER.

B. WHY JAVA?

Java is a modern programming language with many features that make it a good choice for application programming. One feature is that its compiled Java programs can run on any platform without having to be recompiled. Another advantage is that Java is architecture neutral (also referred to as platform independent). JAVAMIX can be run on any platform with a Java Virtual Machine. In a military environment this characteristic is very useful. As an object-oriented programming language, Java provides greater flexibility, modularity and reusability, which is very important for this thesis because it allows future developments and improvements. One of the best features is that Java has an extensive set of pre-defined classes, grouped in packages that can be used in programs,

such as graphical interfaces. Java GUI packages follow the standards used in most commercial applications, making it easy for a user familiar with windows and dialog boxes. Using windows, buttons, text boxes and dialog boxes the user can be alerted, by message boxes, of any mistakes. Java can also display graphs to help the user to make better decisions.

III. CLEARANCE PROCESS

A. SCENARIOS AND CLEARANCE PARAMETERS

One of the most important aspects of Mine Countermeasures is achievement of a desired clearance level based on an input plan. To obtain success in a mission the primarily step is to define the scenario. A scenario for JAVAMIX is considered as a rectangular area that should be cleared by using the resources available.

All necessary parameters are defined in a parameter file where the planners put all the necessary data to accomplish the mission. The user enters the parameter file name through the GUI. Minefield clearance is always in a rectangular area. A clearance plan with two tracks is illustrated in Figure 2, two runs on one and three on the other.

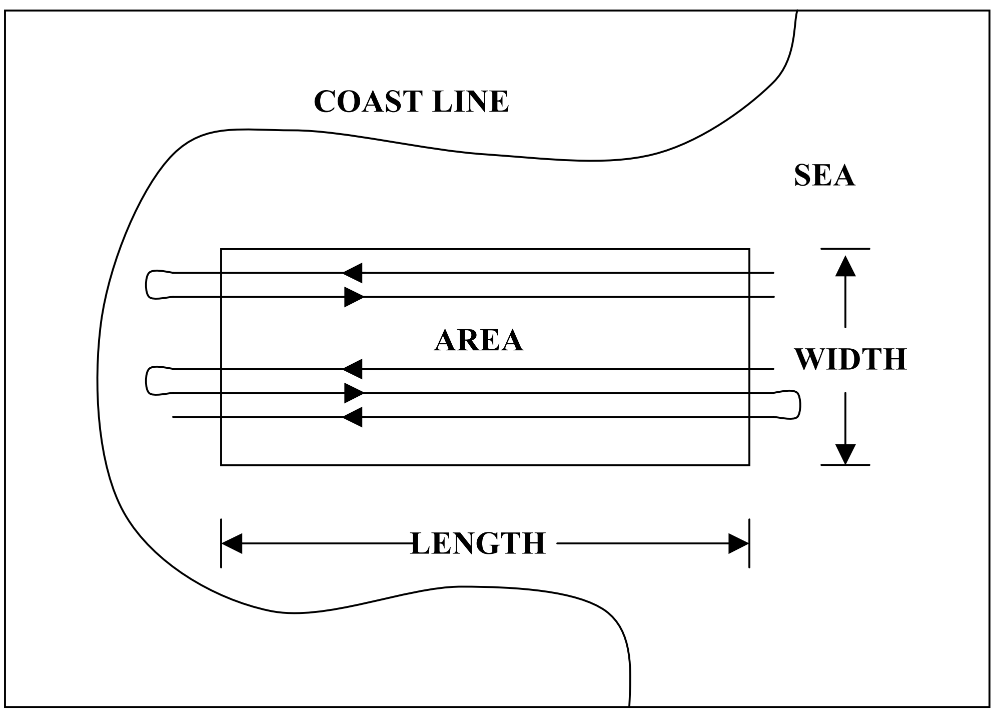

Figure 2. Scenario: “ runs” and “tracks”.

A “track” is the entry point in the minefield for each sweep type. Each track has a track position. The coordinate system has the width of the minefield extending from 0 to width for each track position. A “run” in JAVAMIX is defined as the number of forward and backward passes in a track.

JAVAMIX reads the parameters in the file chosen by the user, using the Class SimpleInput [2], which is a Java program developed to allow reading words and numbers from a text file. The planner can modify the parameters as desired, but they must obey the file format presented in Figure 3. JAVAMIX skips the first two lines of the parameter file (see Figure 3) and reads the number of mine, sweep and resource types. Then it skips line 4 (“RESOURCES:”) of the parameter file and reads the name of the resources in line 5. JAVAMIX also skips line 6 (“MINES:”) and line 8 (“SWEEPERS:”) of the parameter file and reads the name of the mines in line 7 and the name of the sweepers in line 9. After that JAVAMIX reads all the numbers in sequence, disregarding the words. JAVAMIX catches all the exceptions and shows the user through error messages if the file format is wrong or, for example, if he put a probability value greater than one. The parameter file must be in the same folder as all the classes of JAVAMIX.

The scenario is defined by the following inputs read in the parameter file and assigned to its variables in JAVAMIX code as follows, with variables names in italics:

a. Mine Types (*iMax*). Number of expected mine types to be encountered in the minefield.

b. Resource Types (*kMax*). Number of resource types available. Example: ships, helicopters and sleds.

c. Sweep Types (*jMax*). Number of sweep types possible with the resources available. For example, a ship could have two sweep types (magnetic and acoustic).

d. Countermeasure for sweep (*ind[j]*). For each sweep type, *ind[j]* = 0 indicates sweeping and *ind[j]* = 1 hunting.

e. Width (*width*) of the minefield in yards.

f. Length (*length*) of the minefield in nautical miles.

g. Trapezoid Adjustment Factor (*tr*). Factor used to soften the corners of actuation curves ($0 < tr < 1$).

h. Hunting Time (*ht*). Time, in hours, required by a hunting sweep type to identify a mine.

i. Navigation Error (*sig[j]*). Standard Deviation, in yards, for each sweep type.

j. Usage of resource type per unit of sweep type (*h[k][j]*). Usage connects sweep types to resource types. Usage *h[k][j]* = 2 indicates lethal detonation will kill resource unit and sweep device, *h[k][j]* = 1 indicates that resource k is required for sweep type j, but not vulnerable, and *h[k][j]* = 0 means that resource k is not required for sweep type j.

k. Order of entry into the minefield (*seq[j]*).

l. Turn time (*turn[j]*). Time necessary, in hours, for a sweeper to make a turn between runs.

m. Velocity (*vel[j]*) of the sweeper while working.

n. Duty ($duty[j]$). Dimensionless factor used to convert time-on-track to the number of hours ($hours[j]$) actually required.

$$hours[j] = duty[j] \times (turn[j] + length / vel[j])$$

o. Probability Actuator Setting ($act[i]$) by mine type, where $0 < act[i] < 1$.

p. Sweep Front ($a[i][j]$). The width of the actuation curve for mine types with values greater than zero ($a[i][j] > 0$).

q. Actuation Probabilities ($b[i][j]$). The height of the actuation curve for mine types with values between 0 and 1 ($0 < b[i][j] < 1$).

r. Dangerous Front ($af[i][j]$). The width within which sweeping a mine may be lethal with values greater than zero ($af[i][j] > 0$).

s. Damage Probabilities Conditional on Detonation ($bf[i][j]$). Probability of lethality with values between 0 and 1 ($0 < bf[i][j] < 1$).

```
MINE TYPES, SWEEP TYPES, RESOURCE TYPES
NOTE THAT THE LAST SWEEP TYPE IS TARGET TRAFFIC
   5   8   6
RESOURCES:
SWEEPER HELICOP EODTEAM    SLED    GEAR  GUINEA
MINES:
BOTMAG  BOTACU  BOTPRS  TETMAG  TETCNT
SWEEPERS:
        SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT  TARGET

INDICATOR FOR WHETHER MINE COUNTERS WORK AS COUNTERMEASURE FOR SWEEP
   0   0   1   0   1   1   0   1
WIDTH(YDS), LENGTH(N.MI.), TRAPEZ, HUNT ID TIME(HR.)
        1000.0      5.00     .15     .20
NAVIGATION STANDARD ERROR BY SWEEP TYPE
          20.00   20.00   20.00   20.00   30.00   20.00   40.00   60.00
TABLE H(K,J)  USAGE OF RESOURCE K PER UNIT OF SWEEP J
         SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT
MCMSHIP       2       1       2       0       0       0       0
HELICOP       0       0       0       1       0       1       1
EODTEAM       1       2       0       1       0       0       0
   SLED       0       0       0       0       0       2       0
   GEAR       0       0       0       0       0       0       2
 GUINEA       0       0       0       0       2       0       0
RELATIVE RESOURCE VALUES VAL(K) FOR OPTIMIZATION, LAST FOR FIRST TRANSIT
           2.00    2.00    2.00    0.50    0.50    2.00   10.00
ORDER OF ENTRY INTO MINEFIELD SEQ(J)
              4       5       6       3       7       2       1
TABLE TURN(J) HOURS PER RUN OF CHANNEL (HOURS)
            .20     .10     .20     .10     .20     .10     .20
TABLE VEL(J) VELOCITY WHILE WORKING
           3.0     1.0     5.0    20.0     5.0    30.0    10.0
TABLE DUTY(J) MULTIPLY TIME ON TASK BY DUTY TO GET REAL TIME
           2.0     4.0     3.0    10.0     3.0    10.0    12.0
PROBABILITY ACTUATOR SETTINGS BY MINE TYPE
ACT(I)     0.1     0.5     0.33    0.33    1.0
TABLE A(I,J) SWEEP FRONT
         SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT  TARGET
BOTMAG   200.00  100.00  200.00   50.00  100.00   80.00     .00   50.00
BOTACU   100.00  100.00   50.00   50.00  100.00  100.00     .00   50.00
BOTPRS   150.00  100.00     .00   50.00  100.00     .00     .00   20.00
TETMAG   200.00     .00  200.00   10.00  100.00   50.00  150.00   70.00
TETCNT   200.00     .00     .00     .00  100.00     .00  150.00   70.00
TABLE B(I,J) ACTUATION PROBABILITIES
         SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT  TARGET
BOTMAG      .50     .50     .50     .50     .50     .50    1.00     .50
BOTACU      .50     .50     .50     .50     .50     .50    1.00     .50
BOTPRS      .50     .50     .50     .50     .50     .50    1.00     .50
TETMAG      .50     .50     .50     .50     .50     .50    1.00     .50
TETCNT      .50     .50     .50     .50     .50     .50    1.00     .50
TABLE AF(I,J) DANGEROUS FRONT
         SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT  TARGET
BOTMAG    20.00   10.00   50.00     .00   50.00   50.00     .00   50.00
BOTACU    20.00   20.00   50.00     .00   50.00   50.00     .00   20.00
BOTPRS    20.00   30.00     .00     .00   50.00     .00     .00   20.00
TETMAG    30.00     .00   50.00     .00   50.00   50.00  150.00   70.00
TETCNT    40.00     .00     .00     .00  100.00     .00  150.00   70.00
TABLE BF(I,J) DAMAGE PROBABILITIES CONDITIONAL ON DETONATION
         SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT  TARGET
BOTMAG      .15     .15     .15     .15     .50     .15     .15    1.00
BOTACU      .15     .15     .50     .15     .50     .15     .15    1.00
BOTPRS      .15     .15     .15     .15    1.00     .15     .15    1.00
TETMAG      .15     .15     .15     .15     .50     .15     .15    1.00
TETCNT      .15     .15     .15     .15     .50     .15     .15    1.00
```

Figure 3. Parameter File.

B. CLEARANCE PLAN

After the user defines the Scenario by choosing the parameter file, JAVAMIX presents the user the parameters read by the program, so that he can check them and then proceed to the next step. If there are any corrections needed, the user must modify the parameter file and start over. After checking the data, the user can enter the "tactical" inputs that depend on circumstances and time. JAVAMIX leads the user through the GUI and the following inputs are requested:

a. Number of Resources (*nu[k]*).

b. Number of Tracks (*ntrk[j]*).

c. Track Positions (*x[t][j]*).

d. Number of Runs per Track (*runs[t][j]*).

e. Mean (*kzA[i]*) and Standard Deviation (*kzB[i]*) for the number of each mine type expected.

C. NUMBER OF MINES PRESENT

JAVAMIX defines the number of mines present as Washburn does in [4]. The reader should note that the equation numbers and references in the following long quote are from that reference:

> MIXER differs from current minesweeping TDAs in requiring the user to guess the number of mines of each type. In addition to guessing the number of mines of each type, the user of MIXER must also give a *standard deviation* for each guess as an indication of the amount that the guess might be off. MIXER interprets the guess itself as the *mean* μ of the random number X of mines actually present. Letting σ be the input

standard deviation, the variance of X is taken to be σ^2. Each replication of the minefield in the simulation has a different value for X, but the values are all sampled from a distribution with *mean* μ and variance σ^2, except as noted below.

The random variable X, the number of mines of a particular type, is not completely described by the two inputs μ and σ; some distributional assumption must be made. MIXER assumes that X has a *Katz* distribution, a class indexed by two parameters α and β that are related to μ and σ by the equations

$$\mu = \alpha/(1-\beta) \qquad (1.1)$$

$$\sigma^2 = \alpha/(1-\beta)^2 \qquad (1.2)$$

The requirements on α and β are $\alpha \geq 0$ and $\beta < 1$, plus an additional restriction if $\beta < 0$. Principal properties of Katz distributions are reported in [2]. The class consists of generalized negative binomial ($\beta > 0$), Poisson ($\beta = 0$), and binomial ($\beta < 0$) distributions. Katz distributions are closed under the sample-and-subtract operation, which makes them natural for studying minesweeping. More precisely, suppose every mine is independently removed with probability p, and that the number of mines removed is observed to be y. Then the distribution of the number of mines remaining, given y, is still Katz, but with revised parameters

$$\alpha' = (1-p)(\alpha - \beta y) \qquad (1.3)$$

$$\beta' = (1-p)\beta \qquad (1.4)$$

Equations (1.3) and (1.4) are derived in [5]. Katz distributions appear to be the largest class that is closed under the sample-and-subtract operation. The closed-ness of parts of the Katz class has been known and exploited for mine warfare purposes for some time [6].

The advantage of dealing with a closed class is that, if one conceives of minesweeping as a succession of sample-and-subtract stages, then the number of mines in each stage always has the same kind of distribution. One can therefore imagine running MIXER several times in the process of clearing a minefield, once for each stage.

There are no restrictions on μ and σ other than being nonnegative, but there are some (μ, σ) pairs for which there is no Katz distribution. There is no Katz distribution if $\mu = 7.5$ and $\sigma = 0$, for example, since Katz distributions are concentrated on nonnegative integers. Rather than stopping with an error in such cases, MIXER finds the closest Katz distribution by modifying σ. If $(\mu, \sigma) = (7.5, 0)$ is input, for example, MIXER will make $(\alpha, \beta) = (120, 7.5)$. This corresponds to a binomial distribution with 8 trials and 15/16 success probability, which has the correct mean (7.5), but variance of 15/32, rather than 0. Such corrections are never necessary if $\sigma^2 \geq \mu$.

Operationally, the biggest defect of Katz distributions is that they place no special weight on the number 0, whereas X is *a priori* likely to be either 0 or "many". In the event that an unexpected mine type is encountered in some phase of minesweeping, the simplest recourse would be to augment the inputs for the next phase with a guess at the number of *remaining* mines of the new type.

D. MONTE CARLO SIMULATION

Monte Carlo Simulation is a method that involves random sampling. Monte Carlo calculations are applied to problems that can be formulated in terms of probability and are usually carried out by computer. In Sea Mine Warfare, if applied with a large number of iterations, this type of simulation can be very useful. After reading the Scenario and the clearance plan, JAVAMIX asks the user the number of replications (in hundreds) desired. As described in [4], the following operations take place within the Monte Class during the execution:

a. For each mine type, generate the number of mines from a Katz distribution and assign a cross-channel location (*xm[m]*) to each one, and let *mines* be the total number.

b. Intermix the mines in the along-channel direction, letting *minTyp[m]* be the type of the m^{th} mine that the sweepers will encounter in the forward direction. Initially *status[m]* = -1 for all mines, indicating that the mine has not been swept.

c. Considering the sweep types in the order stored in *seq[j]*, make all the runs forward, backward, etc., until all runs and sweep types have been considered. When an unswept mine is encountered, test whether it actuates, and, if so,

whether the detonation is lethal to a resource unit. When a sweep resource of type *k* is lost, reduce the number *nun[k]* of remaining resources, and, if necessary the number *nn* of units still sweeping simultaneously.

d. When all sweeping is done, pass target traffic (transitors) through the minefield using similar logic.

e. Convert the collected totals to averages and output.

E. CLEARANCE RESULT

The clearance result is presented in a DOS window as shown in Figure 4.

```
******************************************************************************
                 NOW RUNNING 1000 REPLICATIONS.
------------------------------------------------------------------------------
UNIT RUNS BY SWEEP TYPE, RELATIVE TO NUMBER PLANNED (****** MEANS N/A):
        SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT
PERCENT 98.13   95.35   95.58   100.00  98.46   90.08   54.03

AVERAGE NUMBER OF MINES SWEPT BY SWEEP TYPE:
        SHPHNT  EODHNT  SHPMAG  HELHNT  GUINEA  HELSWP  HELCUT  UNSWEPT
BOTMAG   4.83    0.11    0.05    4.24    0.01    1.13    0.00    0.50
BOTACU   0.68    0.16    0.00    1.04    0.08    3.33    0.00    1.15
BOTPRS   2.59    0.12    0.00    2.64    0.06    0.00    0.00    0.74
TETMAG   1.04    0.00    0.06    0.09    0.02    0.28    4.35    0.18
TETCNT   2.12    0.00    0.00    0.00    0.08    0.00    6.47    0.47
TOTAL   11.26    0.39    0.11    8.01    0.25    4.74   10.82    3.04
RESOURCE LOSSES TO MINE TYPE:
        SWEEPER HELICOP EODTEAM SLED    GEAR    GUINEA
BOTMAG  0.01    0.00    0.00    0.10    0.00    0.00
BOTACU  0.00    0.00    0.00    0.25    0.00    0.01
BOTPRS  0.01    0.00    0.00    0.00    0.00    0.02
TETMAG  0.01    0.00    0.00    0.03    0.60    0.00
TETCNT  0.06    0.00    0.00    0.00    0.83    0.03
TOTAL   0.09    0.00    0.01    0.38    1.43    0.07
SEQUENTIAL THREAT: 0.009 0.008 0.008 0.008 0.007 0.007 0.005 0.006 0.006 0.006
AVERAGE LOSSES OUT OF 10 TRANSITORS: 0.069
AVERAGE CLEARANCE TIME: 439.03 HOURS
```

Figure 4. Clearance Output

The interpretation of the output shown in Figure 4 is the following:

a. The first statement shows the user the number of replications chosen.

b. The first row of the output corresponds to the unit runs by sweep type, relative to number planned. For example, only 54.03% of the planned tracks for mechanical sweeping (HELCUT) are completed, because loss of gear forced an early termination.

c. The first table shows the effectiveness of clearance types in removing mines.

d. The second table shows the effectiveness of mines in removing resources.

e. The last three outputs correspond to the Sequential Threat (probability that the i^{th} transitor is lost) for each of the ten transitors, the Average Losses out of ten transitors, and the Average Clearance Time for clearance plan.

IV. GRAPHICAL USER INTERFACE OVERVIEW

This is a walkthrough of the JAVAMIX GUI. The figures show pages, error messages, and output.

A. JAVAMIX INTERFACE PAGES

The following pages are presented to the user when running JAVAMIX.

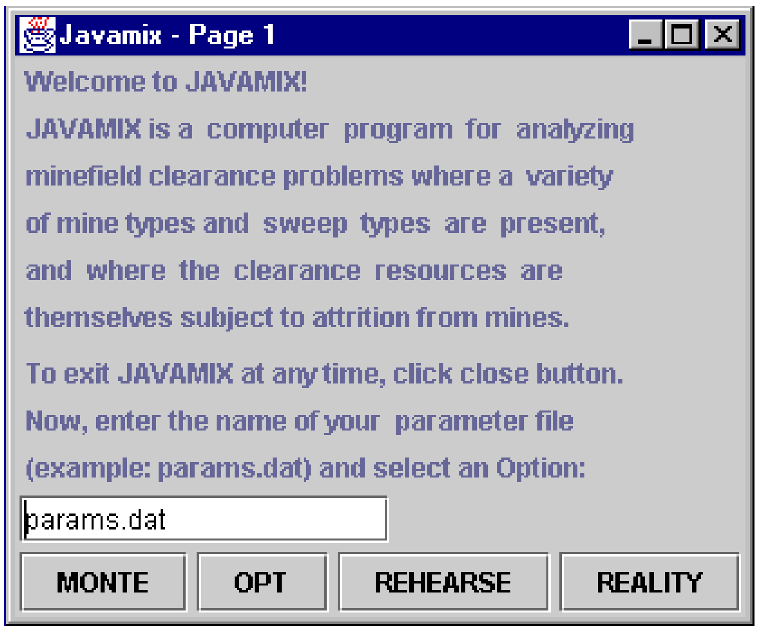

Figure 5. GUI - Page 1.

Page 1 displays options and initial instructions for the user. The user can exit JAVAMIX, at any time, by clicking the upper-right “close” button. As a default, the “params.dat” file will be presented to the user. The user enters the parameters file name and chooses an option. Options “OPT”, “REHEARSE” and “REALITY” are not available. The user selects the option “MONTE” by clicking the mouse.

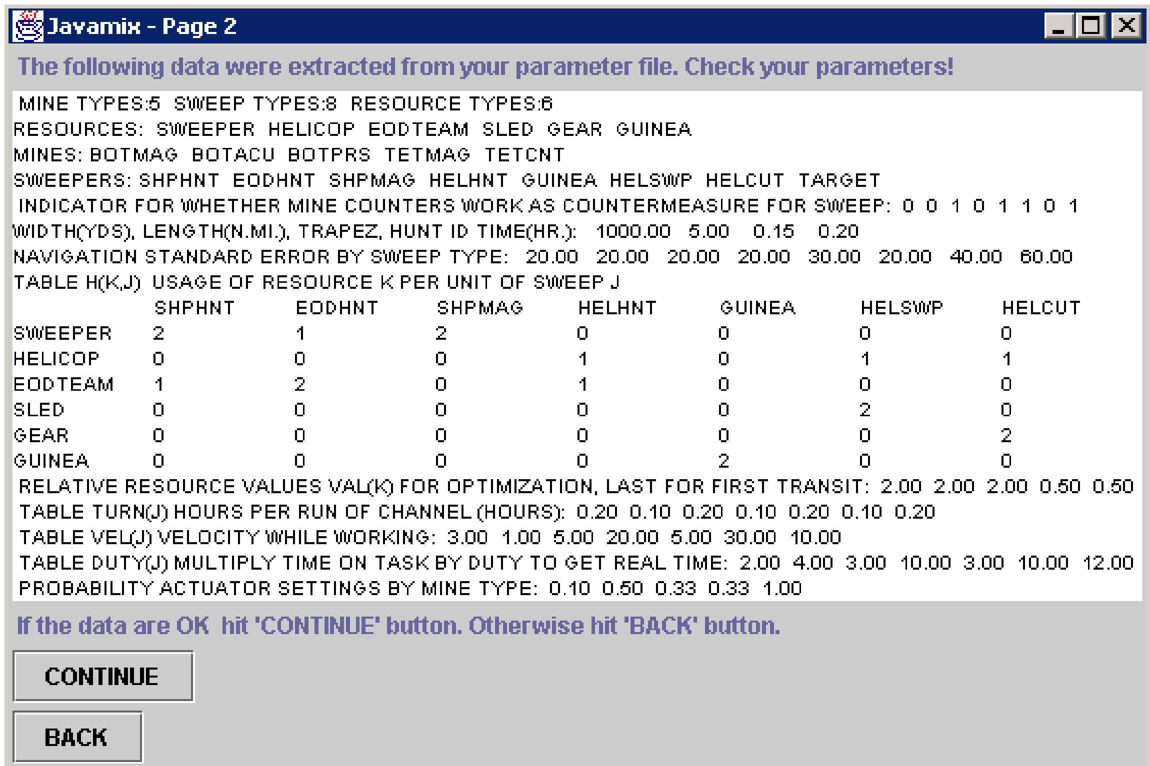

Figure 6. GUI - Page 2.

Page 2 shows the first part of the parameters read by JAVAMIX. After checking the parameters, the user continues by clicking the "CONTINUE" button or returns to the previous page by clicking the "BACK" button.

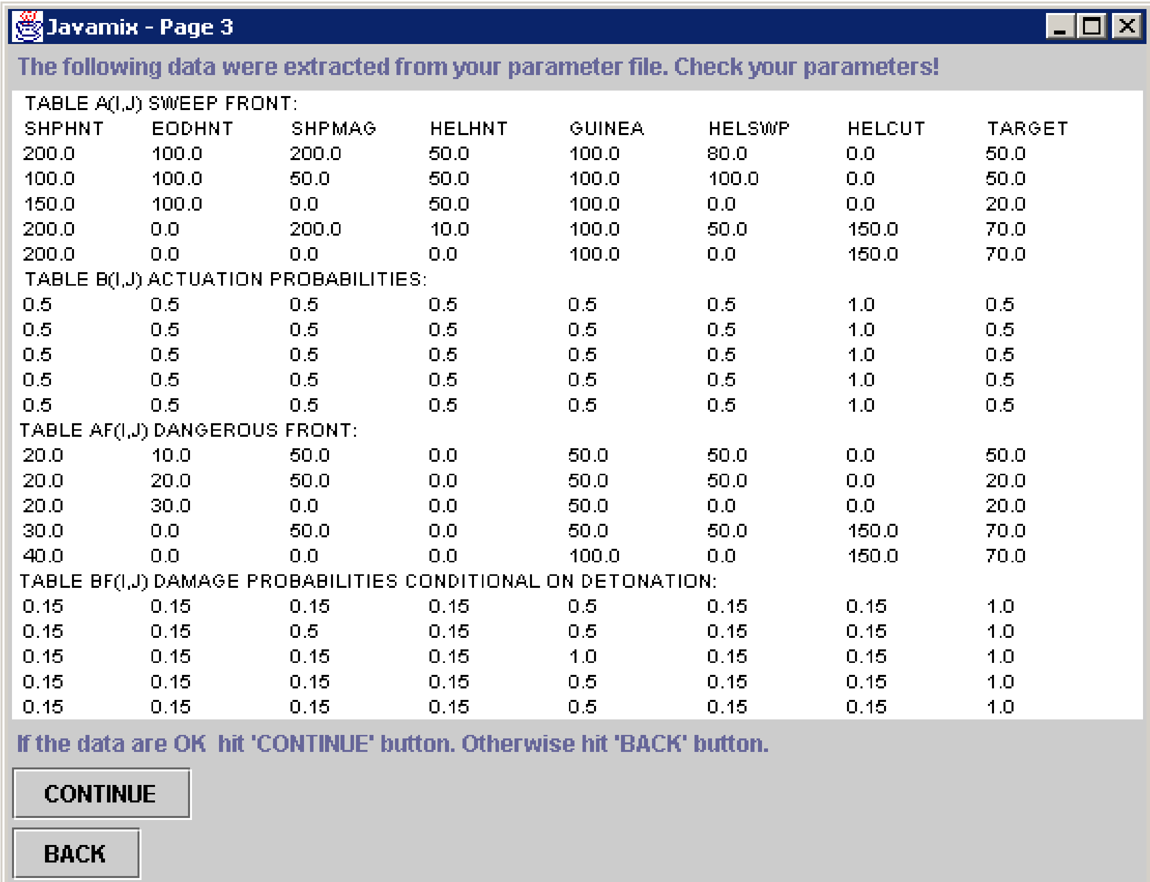

Figure 7. GUI - Page 3.

Page 3 shows the second part of the parameters read by JAVAMIX.

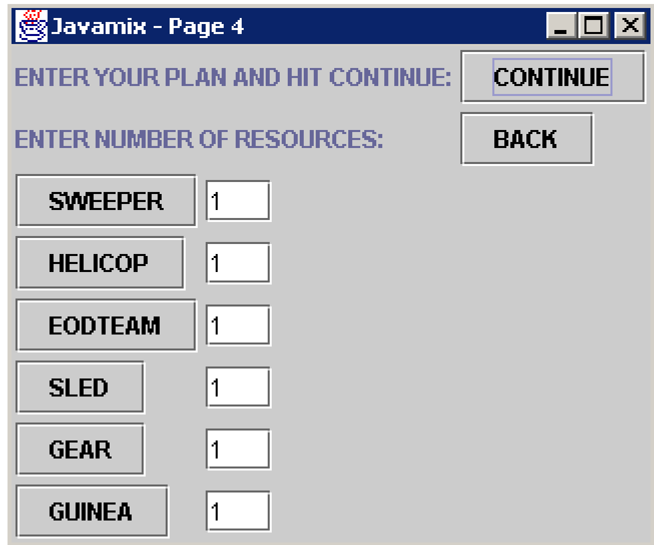

Figure 8. GUI - Page 4.

Page 4 presents the user the type of resources available; they are all defaulted to 1. The user enters the number of resources desired.

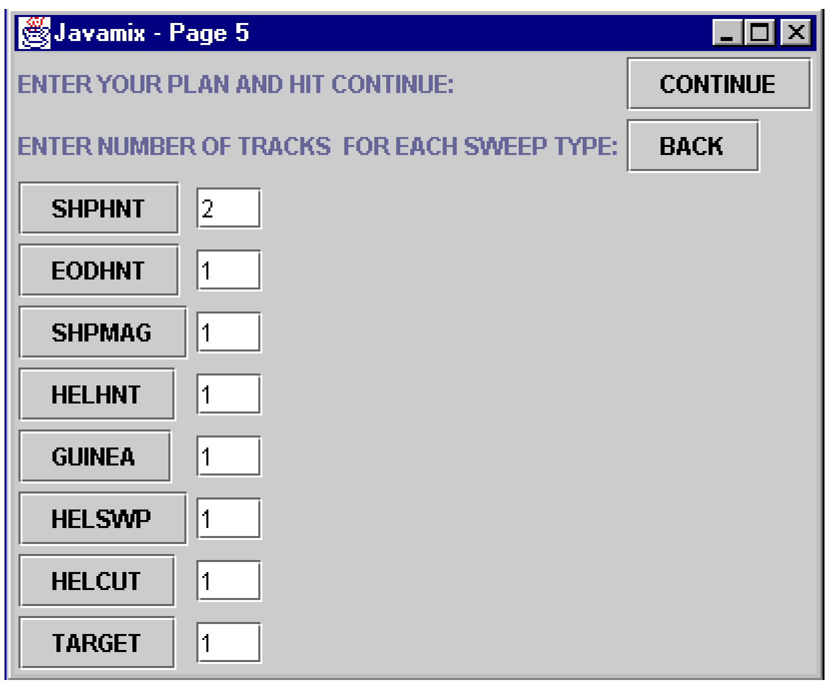

Figure 9. GUI - Page 5.

Page 5 presents the user the type of sweepers available. The user enters the number of tracks for each sweep type (see Figure 2).

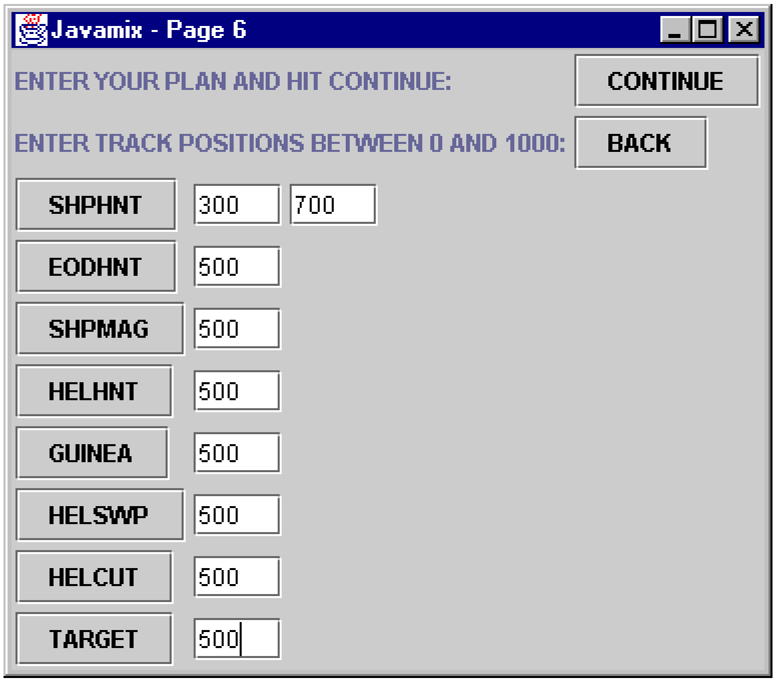

Figure 10. GUI - Page 6.

The number of fields available to enter the track positions is based on the number of tracks for each sweep type chosen on the previous page. For example, the number of tracks chosen for SHPHNT was two (see Figure 9). Each track has a position in the minefield between the left (0) and right-hand edge.

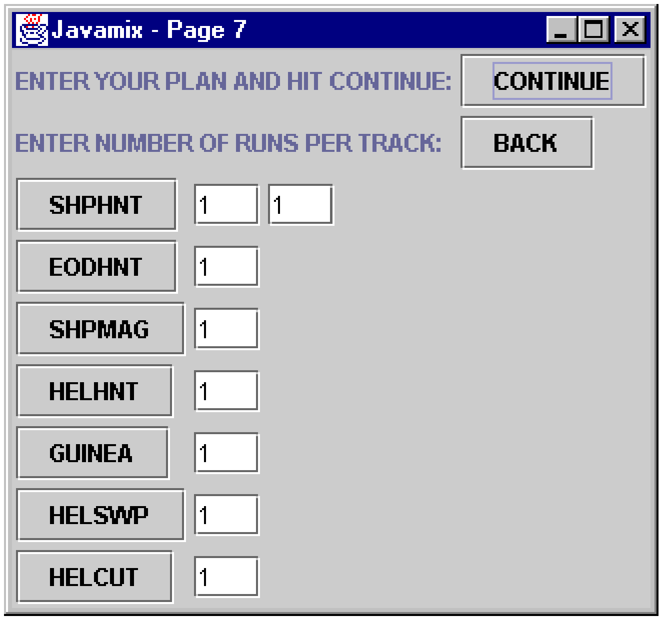

Figure 11. GUI - Page 7.

Page 7 presents the user the type of sweepers available, so that the user can enter the number of runs per track. The number of fields available to enter the number of runs per track is based on the number of tracks chosen on JAVAMIX page 5 in Figure 9. Each run corresponds to forward and backward runs. One run means one forward run. Two runs means one run forward and one backward. No input is required for targets, each of which makes a single run.

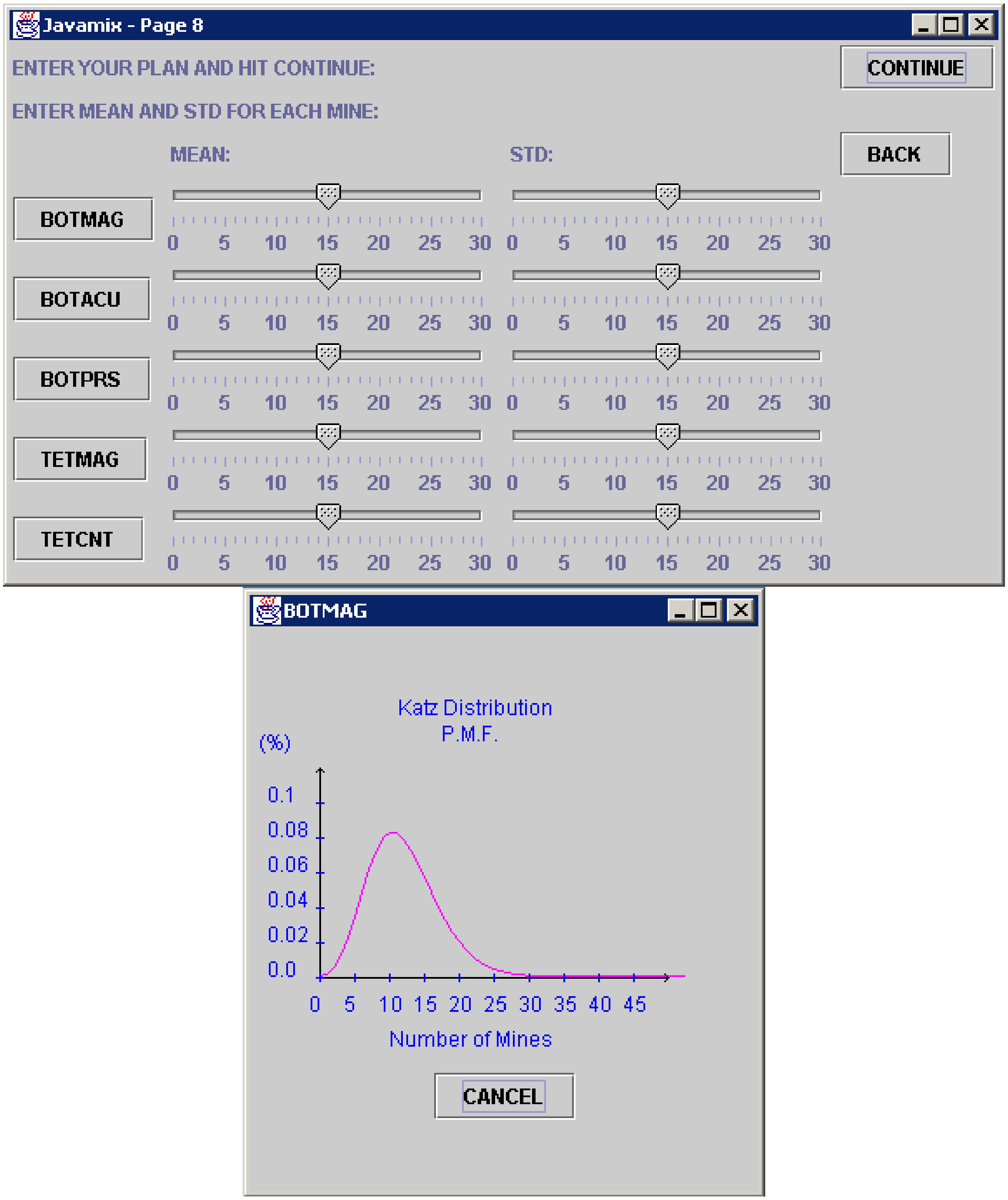

Figure 12. GUI - Page 8.

Page 8 presents the user the type of mines expected. The user can enter the mean and standard deviation for the number of each mine type expected by dragging the

sliders. When the user drags, for example, the slider for "BOTMAG", a dynamic graph with the Katz distribution for the mine type will be presented to the user.

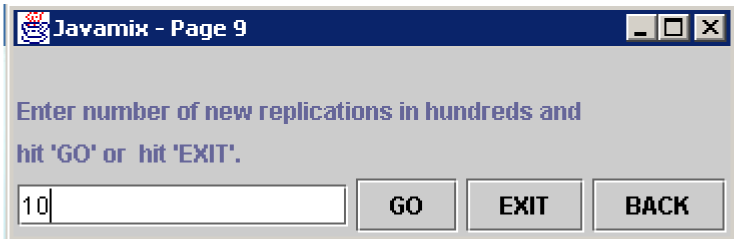

Figure 13. GUI - Page 9.

Page 9 presents the user the option to run the simulation. The user enters the number of replications (in hundreds) desired or uses the default value (10 hundreds). After selecting the number of replications desired, the user clicks the "GO" button. A progress bar is presented in the DOS window while the simulation is running. Each time the simulation is executed, the results are presented in a DOS window (see Figure 14). The user can run the simulation as many times as he wants by changing the number of iterations desired and clicking the "GO" button. As desired, the user exits JAVAMIX or returns to the previous page by clicking the "BACK" button.

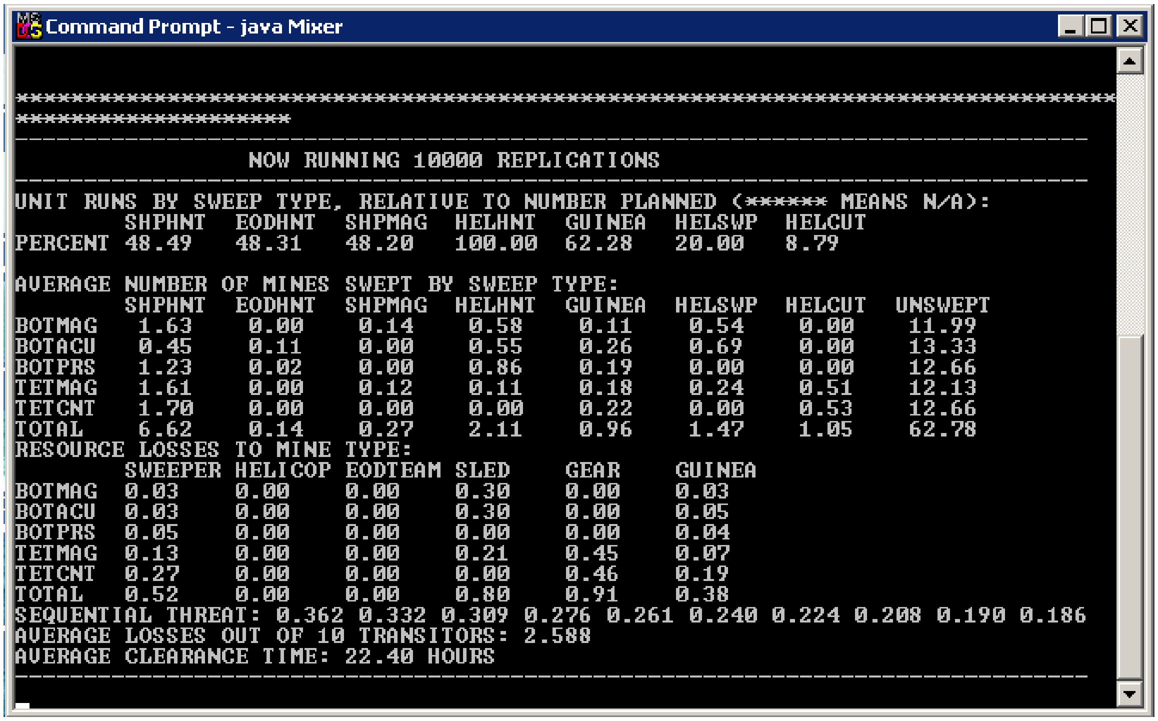

Figure 14. DOS output.

Simulation Output. This is the output presented to the user after running the simulation. The user can run the simulation as many times he wants. If desired, the user may change the number of replications.

B. ERROR AND INFORMATION WINDOWS

The following figures represent the error messages and information windows.

Figure 15. Error message when no file name is introduced.

Figure 16. Error message for a parameter file that does not exist.

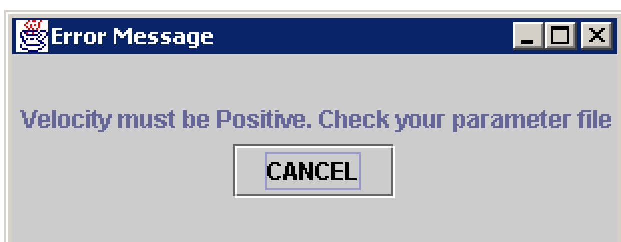

Figure 17. Error message if a wrong parameter is found in the parameter file.

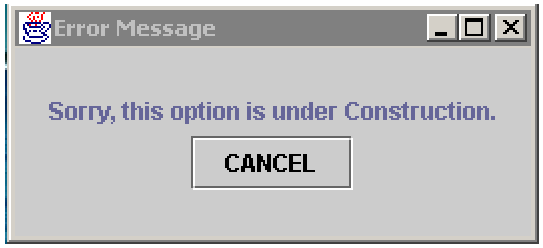

Figure 18. Error message for wrong option selected.

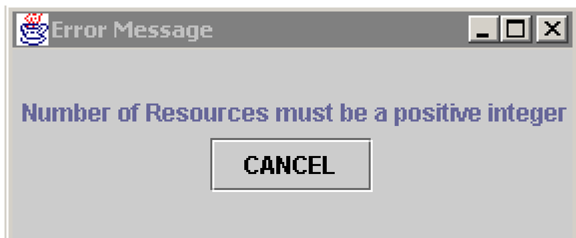

Figure 19. Error message for wrong input.

C. JAVAMIX CODE

JAVAMIX software contains the following classes: Mixer.java, Monte.java, Katz.java, Rand.java, Normal.java, DrawCurve.java, CurvePlot.java, MeanSlider.java, SigmaSlider.java, SliderListener.java, and SimpleInput.java. Mixer Class contains all the methods which operate the Graphical User Interface. To initialize the Simulation the user enters the name of the parameters file and JAVAMIX reads it using objects from the Class SimpleInput [2]. The parameter file must be in the same folder as all the classes. After checking for errors of file format and wrong inputs in the parameters file, the GUI guides the user through the execution of JAVAMIX. The GUI provides immediate identification of user errors and indicates corrective action. JAVAMIX uses the Classes DrawCurve, CurvePlot, SigmaSlider, MeanSlider SliderListener and KatzPMF to draw the Katz probability mass function for each mine type expected. After reading the parameters, Mixer Class invokes a Monte Class object that uses data from the parameters file and user's inputs. Monte Class invokes objects from classes Rand, Normal and Katz. Finally, based on the parameters and clearance plan, JAVAMIX asks the user the number of replications desired and runs the Monte Carlo simulation presenting in a DOS window the results of the simulation.

The reader can obtain a copy of JAVAMIX by contacting Professor Alan R. Washburn or Professor Gordon H. Bradley at Naval Postgraduate School, Monterey, CA.

V. DISCUSSION AND FUTURE DEVELOPMENTS

JAVAMIX provides a Tactical Decision Aid for mixed minefield clearance with a Graphical User Interface. Compared to its predecessor MIXER, JAVAMIX improves the interaction between the user and the software. The author respected all the conventions established by MIXER in the Fortran code, but the Java code should be analyzed more closely to make it faster. The Fortran version is not user friendly but is faster than the Java version. Another limitation is that the parameters in JAVAMIX are read from a file. An improvement would be to place all the parameters in a database where JAVAMIX could access them as directed by the user. The current design allows the user to make various parameters files so that he can choose which one to use. Future developments should include the implementation of the other MIXER options: REHEARSE, REALITY and OPT.

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[2] Barnes, David J. *Object Oriented Programming with Java: An Introduction*, Prentice Hall, pp. 366-372, 2000.

[3] Johnson, N., and Kotz. *Discrete Distributions,* Wiley, New York, pp. 37-43, 1969.

[4] Washburn, A., *MIXER: A TDA for Mixed Minefield Clearance*, Naval Postgraduate School Technical Report, NPS-OR-95-011PR, Monterey, CA 93943, 1995.

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[4] Topley, K. *CORE: Java Foundation Classes*, Prentice Hall, 1998.

[5] Savitch, Walter J. *Java: An Introduction to Computer Science and Programming*, Prentice Hall, 1999.

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